CHAPTER 7

SURVEY RESULTS

A.   Introduction

In this chapter the results of the survey efforts described in Chapter 6 are presented and analyzed.   Two groups of responses are analyzed.   Survey participants who answered questions concerning their willingness to pay an entrance fee to the Grand Canyon National Park are called "user value respondents."   Those who were asked questions concerning their willingness to pay higher electric utility bills to preserve or improve air quality in the Grand Canyon National Park and the surrounding region are referred to as "preservation value respondents."

Section B contains a discussion of various socio-economic and demographic characteristics of the survey respondents.   Section C presents a detailed report of the findings of the user value component of the survey.   The preservation value findings are then presented in Section D.

B.   Socio-economic and Demographic Characteristics of the Sample

There exists in each of the survey subsamples a substantial similarity in gross demographic measures.   These are presented in Tables 13a and 13b. In both cases the Los Angeles and Denver groups are quite close in mean years of formal education, age and income while the Albuquerque group was on average younger, less well educated and received substantially lower incomes. The Chicago group consisted exclusively of preservation value respondents and within this category occupied intermediate positions in education and income. The Chicago respondents' mean age was slightly higher than that of any other city.

Within each city, the user value respondents tended to be younger, better educated and the recipients of higher incomes than the preservation value respondents.   Visitation experience and plans of these respondents is reported in Figure 14.   An exception to this tendency is that in Denver user value respondents reported a mean income slightly less than did existence value respondents.   The difference, though, is sufficiently small that it warrants little discussion given the broad similarities observed.

All these measures, then, bear relationships to one another which enhance their prima facie plausibility as the results of a representative survey of United States citizens. The household size and electricity bills reported similarly tend to confirm that an appropriate sample was selected.

Table 13a

Socioeconomic characteristics of existence value
respondents by city (mean and standard deviation)

|	Number of Respondents	Education (years)	Age (years)	Household size (number of members)	Income (x $1000)	Elect. Bill (dollars/month)
Albuquerque	115	13.60 (2.57)	38.6o (14.47)	3.23 (1.79)	19.02 (11.61)	36.78 (22.99)
Los Angeles	127	14.52 (2.21)	41.05 (14.89)	2.72 (1.70)	28.06 (20.40)	3 6 . 2 7 (25.79)
Denver	110	14.76 (2.34)	40.84 (14.61)	2.54 (1.41)	30.57 (20.64)	58.41 (39.79)
Chicago	98	13.91 (2.39)	42.66 (14.62)	3.8o (1.97)	25.93 (18.25)	55.64 (40.65)

Table 13b

Socioeconomic characteristics of user value
respondent by city (mean and standard deviation)

	Number of Respondents	Education (years)	Age (years)	Household size (number of members)	Income (x $1000)	Elect. Bill (dollars/month)
Albuquerque	61	14.26 (2.29)	35.31 (14.15)	2.88 (1.52)	25.29 (15.90)	36.02 (17.24)
Los Angeles	60	14.90 (2.37)	36.60 (13.06)	2.98 (1.35)	30.77 (20.59)	42.53 (32.68)
Denver	45	15.02 (2.47)	37.11 (15.36)	3.09 (1.67)	30.14 (15.89)	47.67 (26.32)

Figure 14
Grand Canyon Visitation

**Experience and Expectations of User
Value Respondents, by city.**
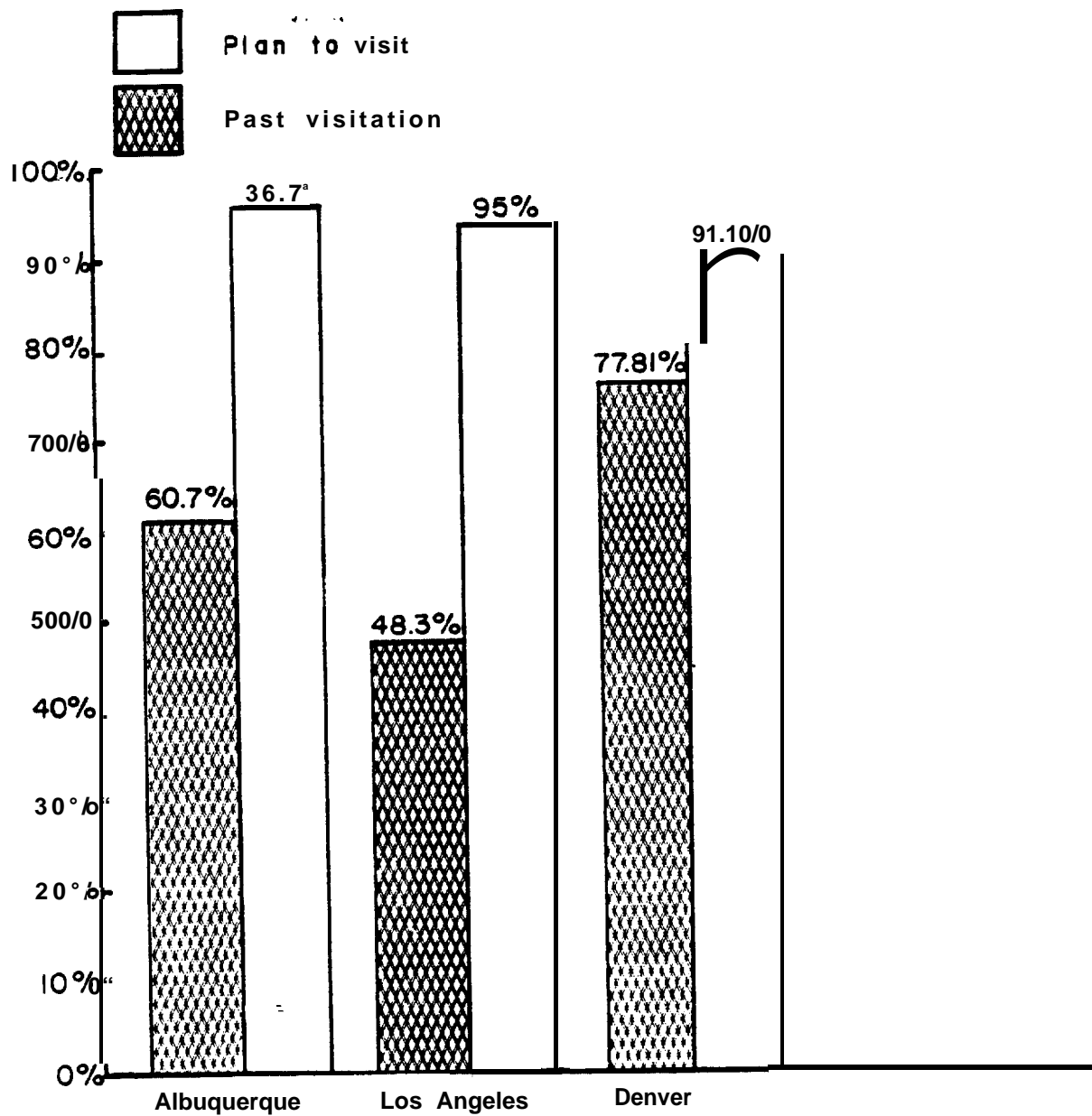
c.   Value in Use to Visitors

The user value survey participants were asked to reveal the maximum additional amount over the current $2.00 daily fee they would be willing to pay for daily admission to Grand Canyon National Park if this fee would be used to maintain specified degrees of air quality. The question was phrased as to ask the maximum total daily fee to maintain each of conditions B, C, D and E over condition A, a situation with severely impaired visibility.

The mean and standard deviation of responses in each city are presented in Figures 15a, 15b and 15c. A notable feature of these results is the uniform display of what might be called increasing returns to scale in air quality. In all three cities nearly half of the total bid for very high visibility was an increase over only slightly diminished clarity. This seems to contradict the conventional assertion that incremental improvements in air quality would yield ever smaller benefits to viewers.

Instead, more serious thought must be given to what has been called the Dubos Hypothesis.[2] This argument holds that for "natural wonders" it is in fact the pristine state that is valued, and that once any degradation has taken place additional damage matters relatively little. The bids for air quality preservation at the Grand Canyon certainly appear to be consistent with this hypothesis, as does the decline in zero bids for greater improvements in air quality. (Tables 14a and 14b present this information.) Were "not significant" not the most frequently given reason for zero bids for the visibility change one would regard this as unremarkable, but the fact that the initial improvements are regarded as insignificant by most zero bidders is in itself noteworthy.
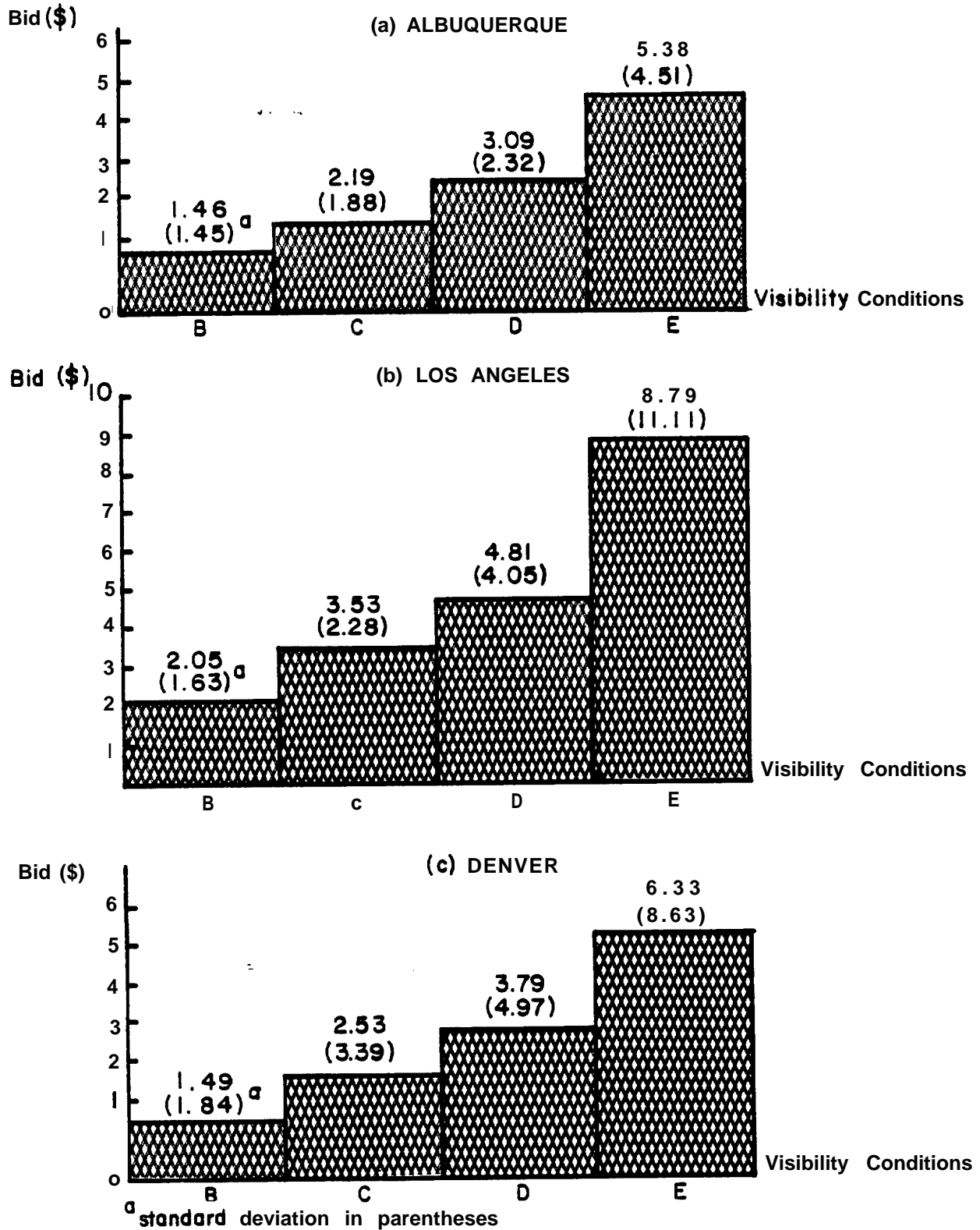
The visitation experience of user value respondents for the Grand Canyon is consistent across income groups and city of residence. Tables 15a and 15b present mean visitation during the previous ten years by city and income class respectively. One interesting aspect is that less than one day per ten years separates the Los Angeles group (with the highest mean visitation) from Denver (with the lowest) as is the similarity of visitation experience among low, middle and high income groups.

As might be expected, use of other National Parks in the region varies considerably among cities and income as well as among the parks themselves. One suspects that a visit to Grand Canyon National Park is the central feature of most parklands tours with trips to other parks and national monuments reflecting any number of family characteristics such as length of vacation, later destinations and knowledge of the region.

Visual quality in these other areas is apparently less valuable to users . than at the Grand Canyon. Figure 16a presents the mean bid of respondents to avoid a regional decrease in average air quality from C to B. The mean regional bid in Albuquerque was $.99 more than the comparable Grand Canyon bid, while in Los Angeles and Denver the increases were $1.24 and $2.40 respectively. Only among Denver respondents did the surrounding region rival the Grand Canyon as a source of viewing pleasure. This might be a result of Denver residents' relatively heavy use of other parklands parks as presented in Table 15a.

Figure 15

**Mean Bid for Specified Visibility Conditions
at Grand Canyon of User Value Respondents,
by City (with standard deviation).**

Bid ($)

(a) ALBUQUERQUE

5.38
(4.51)

3.09
(2.32)

2.19
(1.88)

1.46
(1.45)[a]

Visibility Conditions

B   C   D   E

Bid ($)

(b) LOS ANGELES

8.79
(11.11)

4.81
(4.05)

3.53
(2.28)

2.05
(1.63)[a]

Visibility Conditions

B   c   D   E

Bid ($)

(c) DENVER

6.33
(8.63)

3.79
(4.97)

2.53
(3.39)

1.49
(1.84)[a]

Visibility Conditions

B   C   D   E

[a] standard deviation in parentheses

Sample size (number of households) for Albuquerque,
Los Angeles and Denver is respectively, 61, 60 and 45.

Table 14a

Zero bids by user value respondents for
specified visibility improvements, by city
(number of zero bids)

	A→B	A→C	A→D	A→E
Albuquerque	10	6	4	2
Los Angeles	2	1	1	1
Denver	12	8	6	4

Table 14b

Zero bids by reason among user valw respondents

	not significant	source should pay	other	total
Albuquerque	9	2	1	12
Los Ange les	1	0	2	3
Denver	3	2	2	7

Table 15a

Southwest National Park use patterns (by city)
for user value respondents.   (Number of days
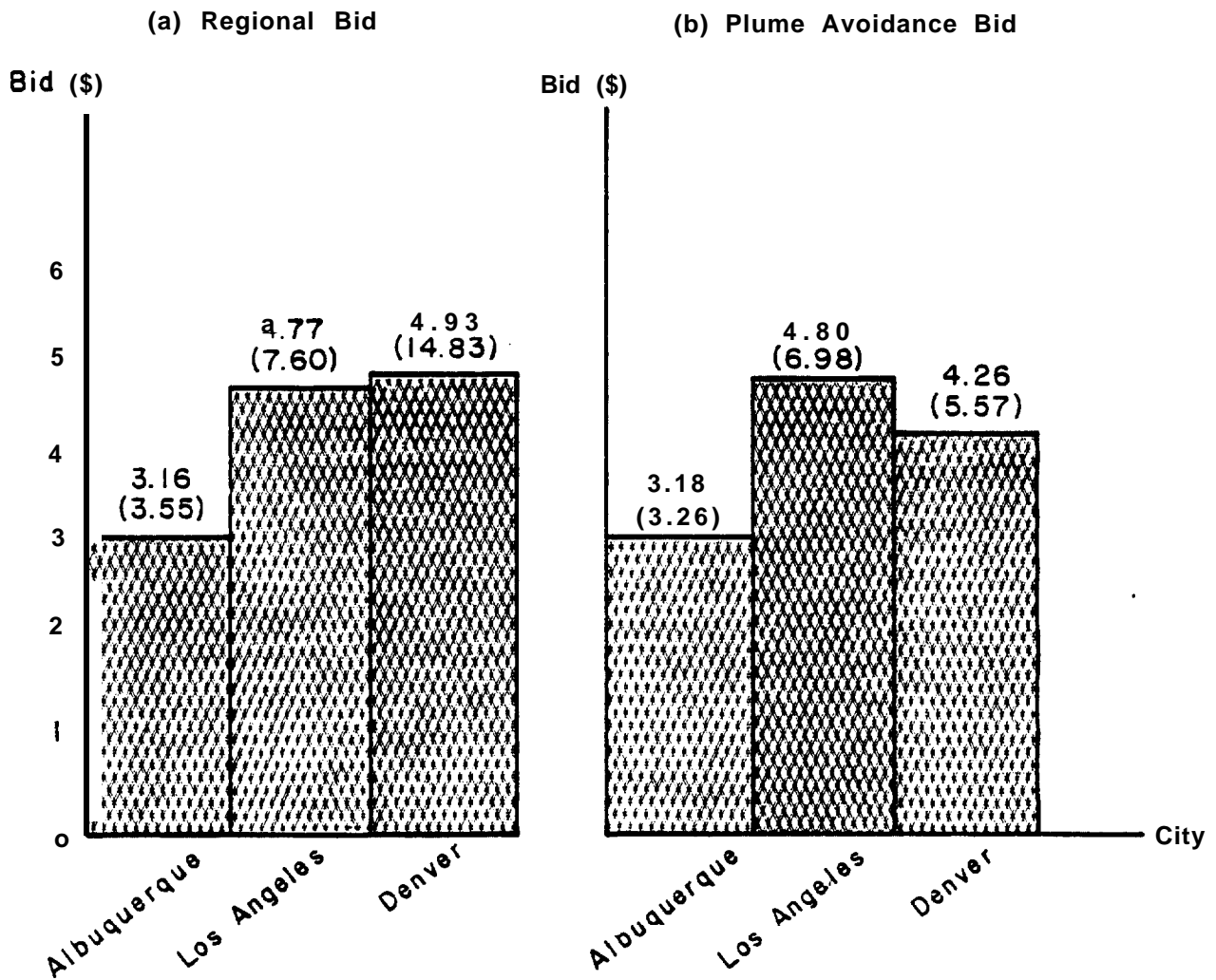at parks during previous ten years; mean and
standard deviation.)

	Grand Canyon	Zion	Mesa Verde	Bryce	Others
A l buquerque	2.69 (3.60)	.47 (1. 06)	1.73 (3.67)	.52 (1.35)	2.08 (3.91)
Los Angeles	3.28 (5.67)	1.77 (4.05)	1.35 (4.21)	1.65 (4. 30)	3.20 (5.99)
Denver	2.51 (2.82)	.80 (1.44)	2.24 (3.66)	1.29 (2.36)	6.27 (7.78)

Table 15b

Use patterns among user value respondents by income c l asses
(Mean days in previous ten years)

	G raod Can yon	Zion	Br yce	Mesa Verde
Low I ncome (14,999 or less)	2.85	.78	.68	2.05
Middle Income (15,000 - 19,999)	2.98	1.26	1.47	1.33
High Income (20,000 or more)	2. 73	.97	1.11	1.92

Figure 16

Mean regional and plume avoidance bid
by user value respondents, by city

(a) Regional Bid

Bid ($)

3.16
(3.55)

4.77
(7.60)

4.93
(14.83)

6
5
4
3
2
1
0

Albuquerque   Los Angeles   Denver

(b) Plume Avoidance Bid

Bid ($)

3.18
(3.26)

4.80
(6.98)

4.26
(5.57)

City

Albuquerque   Los Angeles   Denver

Denver user value respondents were also exceptional in their valuation of plume blight. When asked to reveal the highest daily use fee they would pay to avoid the presence of conspicuous Plume on the horizon, Albuquerque and Los Angeles respondents offered a bid that averaged very close to the bid for the maintenance of slight haze (situation D). In Denver the mean plume avoidance bid was substantially higher than the bid for situation D. The plume avoidance bids are depicted in Figure 16b.

D.   Preservation Value .,

Preservation value respondents in each of the four cities were asked how much they would be willing to pay as an increase in electric utility bills to prevent average visibility declining from situation C to B.

While preservation value respondents were asked their visitation plans and experience, no use was made of this information in the survey except that respondents who had neither visited nor planned to visit the Grand Canyon were forced into the preservation value group. Even so, a substantial portion of the preservation value respondents in each city had visited the Grand Canyon and a majority planned to visit. Figure 17 presents visitation experience and plans for preservation value respondents in each city.

In Table 16 the mean number of days spent at various southwestern national parks can be seen. No data is offered for the Chicago respondents since they were asked simply whether they had visited Grand Canyon and whether they planned such a trip. Among the respondents in the other cities the pattern is much the same as for user value respondents except that the numbers are smaller, as would be expected. Mean days of visitation at the Grand Canyon is approximately the same in each city and Denver respondents had used "other" parks in the region much more than did residents of Albuquerque and Los Angeles.
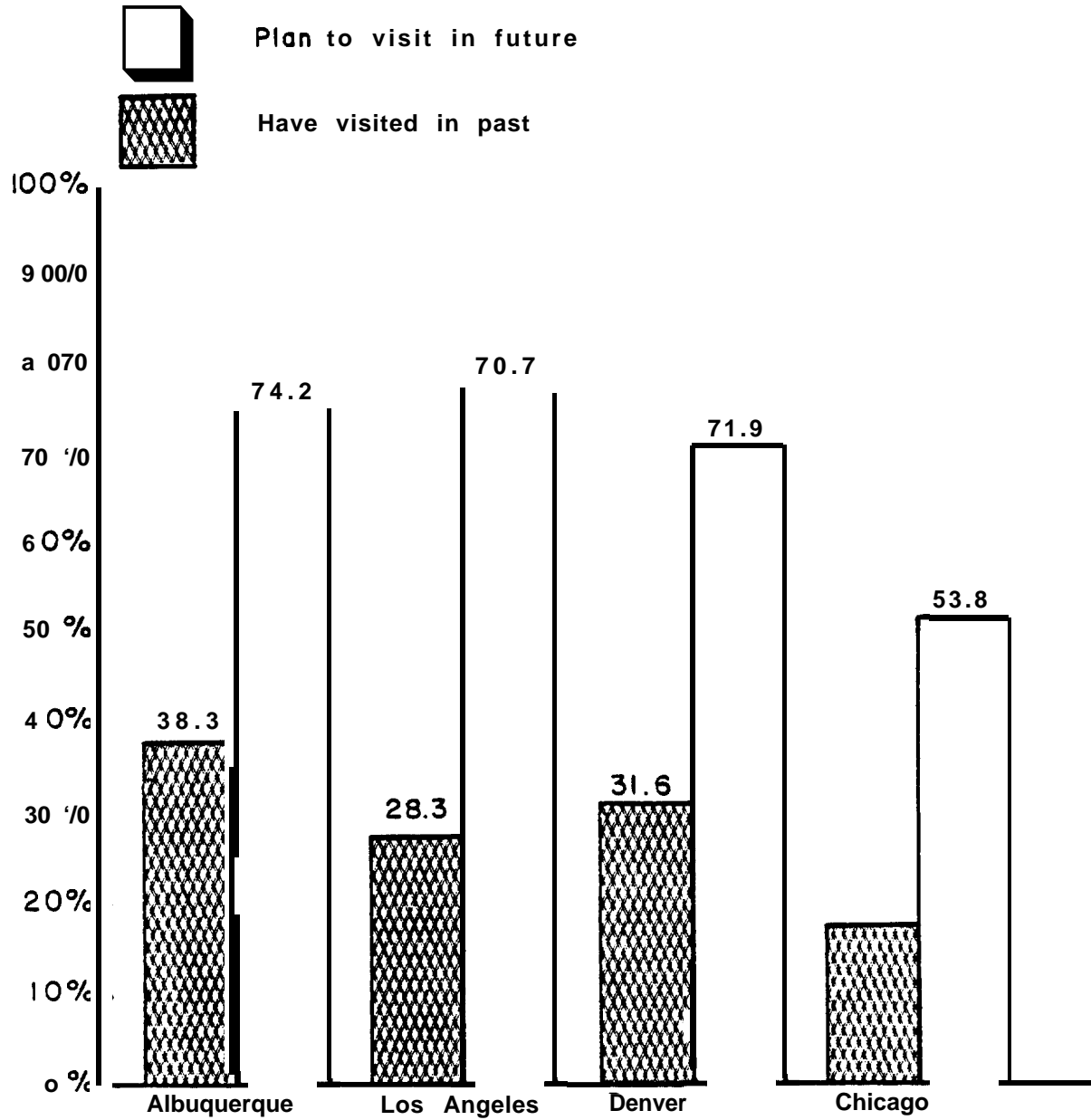
The bids of preservation value respondents, it must be remembered, include both a user value and a pure existence value and thus would be expected to exceed a comparable user value bid. The bids used in the user and preservation value variants of the survey described here are sufficiently distinct that some discussion seems appropriate.

The user value bids, it will be recalled, are formulated as daily increases in entrance fees during a visit that is anticipated. The preservation value bids are to be paid whether or not the respondent actually uses the Grand Canyon or surrounding parklands region. A user value bid comparable to preservation value bids reported would be, then, the product of the daily bid and average number of days per month the fee will be paid. Whether one uses actual visitations in the past or declared intentions, the user value will be insignificant compared to the preservation value bids reported in Table 17. The Grand Canyon bids in this table are for the maintenance of situation C as the average visibility condition. If the same relationships held among preservation values for visibility as among user values, an increase in visibility to situation E would more than double these bids. One hesitates to assert that such is the case, but the consistency with which the Dubos Effect was observed among user value bids requires at least a mention of this possibility.

Figure 17

Grand Canyon visitation experience and expections
of preservation value respondents.

Plan to visit in future

Have visited in past

100%

9 00/0

a 070

74.2

70.7

71.9

70 '/0

60%

53.8

50 %

40%   38.3

31.6

30 '/0   28.3

20%

10%

o %

Albuquerque   Los Angeles   Denver   Chicago

Table 16
Southwest National Park use patterns (by city)
for preservation value respondents.   (Number
of days at parks during previous ten years;
mean and standard deviation.)

	Grand Canyon	Zion	Mesa Verde	Bryce	Others
Albuquerque	1.38 (3.25)	.35 (1.93)	.67 (1.58)'	.28 (1.15)	1.79 (4.72)
Los Angeles	1.17 (3.06)	.83 (1.90)	.45 (1.58)	.68 (1.72)	1.65 (4.40)
Denver	1.11 (2.62)	.26 (.69)	1.50 (2.47)	.21 (.54)	4.25 (6.40)

Table 17
Preservation value bids by city; mean and standard deviation ($)

	Grand Canyon	Additional for Region	Plume Avoidance
Albuquerque	4.09 (11.68)	4.14 (14.41)	4.25 (13.42)
Los Angeles	5.14 (10.79)	4.50 (10.32)	2.84 (4.53)
Denver	3.72 (5.31)	2.89 (4.12)	2.89 (4.54)
Chicago	9.06 (30.49)	7.10 (24.80)	4.32 (13.77)

The preservation value of clean air in the region appears to be substantial to residents of all four cities surveyed, as does the avoidance of plumes. The regional bids presented in Table 17 are bids in addition to the Grand Canyon bid. In an important sense, the plume avoidance bid is also an additional bid since it addresses a separate issue.

The magnitude of these bids when compared to user value bids, especially given the large portion of the respondents who reported an intention to visit the Parklands region, might cause some concern regarding the true apportionment of user option value and pure existence value.

In Figures 18-20 mean bids are presented for respondents by city and by visitation experience and plans. These partitions of the sample suggest that visitation plans are not an overwhelming factor in determining bids and that knowledge acquired through past visits is also of relatively little importance.

Among Albuquerque participants previous or planned travel to the Grand Canyon is associated with larger bid differences than for any of the other cities. This may be a result of Albuquerque's proximity to the Grand Canyon. That is, those who find such things attractive intend to visit the Grand Canyon. The 25.8% of the Albuquerque sample that has no plans to visit the Grand Canyon has the lowest average bid in every classification. A Grand Canyon experience makes much less difference in the mean bid.
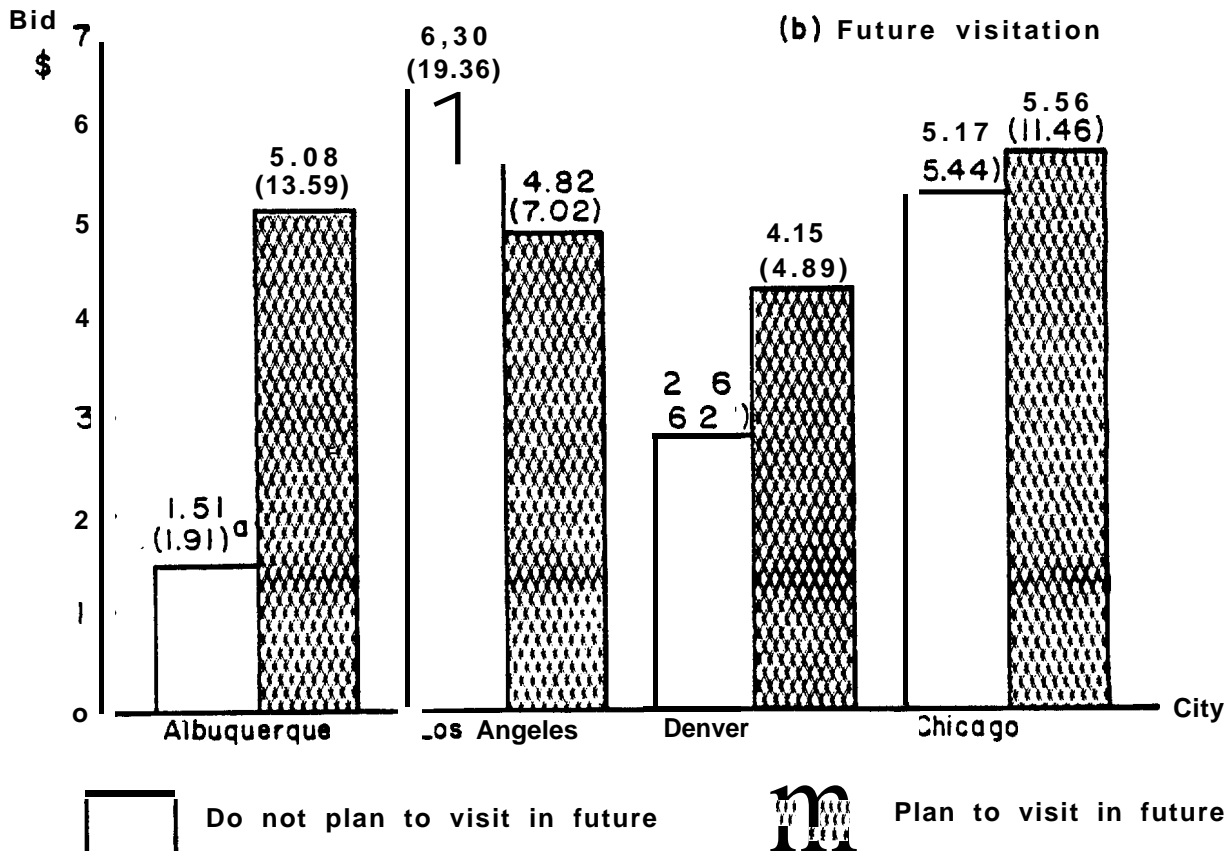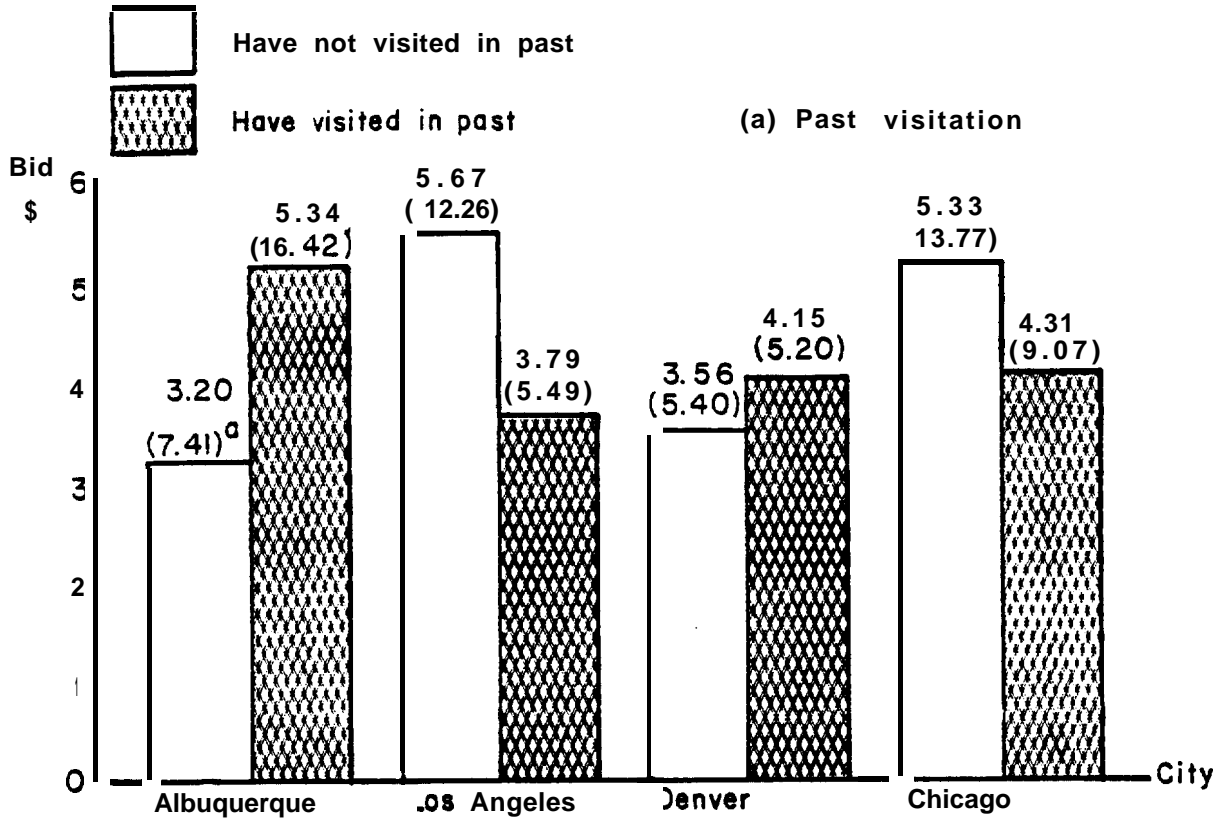
For both Grand Canyon and Parklands total bids the mean bid among Los Angeles respondents was higher without experience or intention to see the Grand Canyon, while visitation plans resulted in higher plume avoidance bids and visitation experience in lower bids. This would seem to suggest a substantial pure existence value.

Past exposure to the Grand Canyon made very little difference in mean Grand Canyon or regional bids in the Denver sample, while anticipated Grand Canyon travel made a large difference in both these measures. The same was true of plume avoidance bids, with travel plans being associated with substantially higher bids.

The Chicago group had the highest mean bid in every category and with only one exception past or planned visits to the Grand Canyon resulted in a lower mean bid., The exception is the Grand Canyon specific bid in which respondents planning a visit made average bids slightly higher than did those not planning a trip to the Grand Canyon.

One would have expected bids to decline with distance, and the substantial margin by which the Chicago bids were higher remains a topic of interest. In the next chapter it will be seen that even when adjustments are made for the income and age of respondents, distance has little discernible effect on bids to preserve air quality in the Grand Canyon.
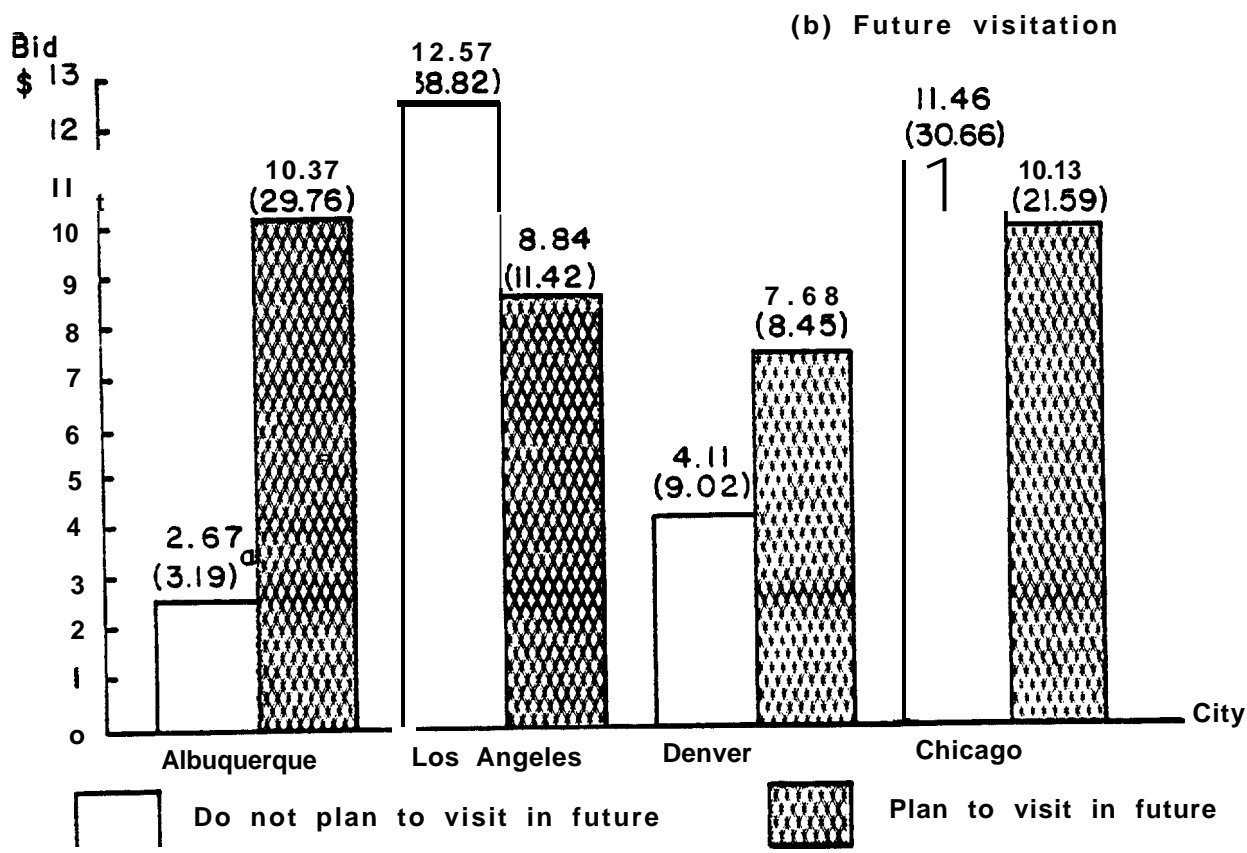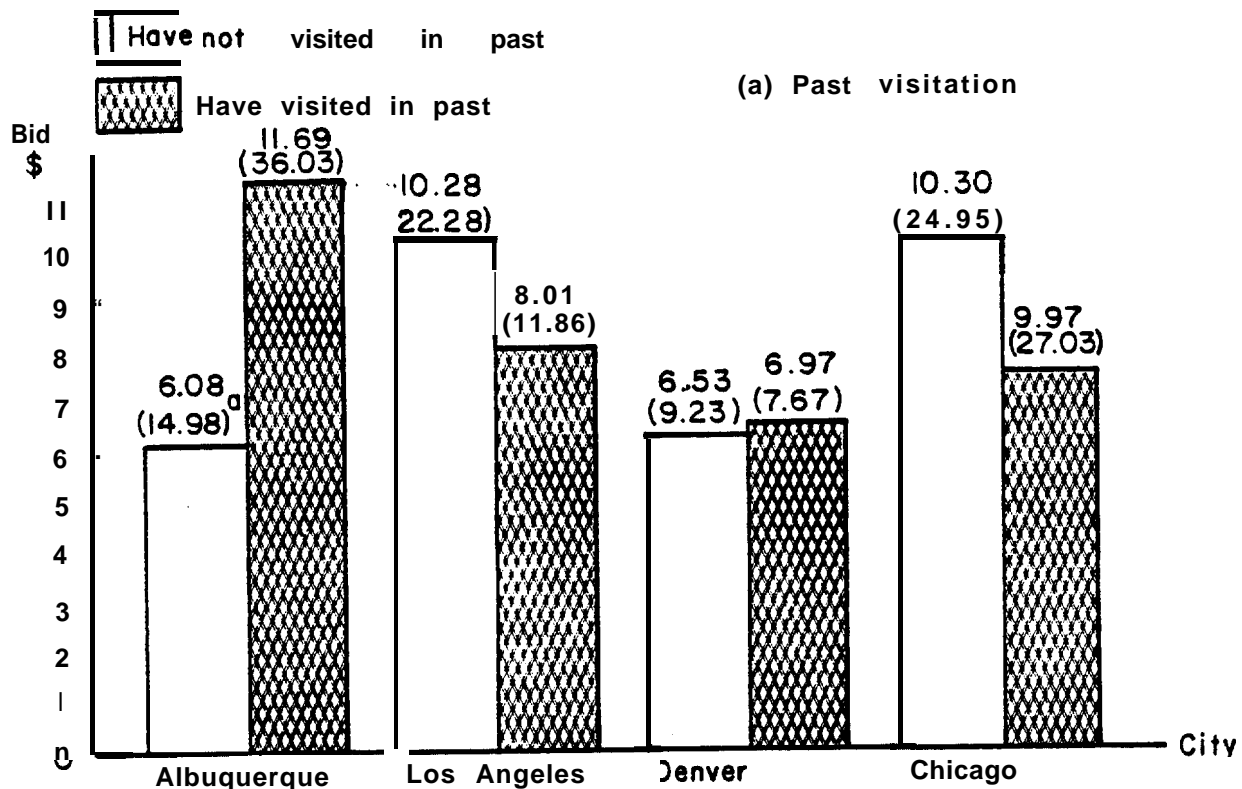
Figure 18
Mean Grand Canyon Bids of preservation value respondents.
by city and past and future visitation

Have not visited in past

Have visited in past

(a) Past visitation

Bid $

Albuquerque 3.20 (7.41)[a] 5.34 (16.42)
Los Angeles 5.67 (12.26) 3.79 (5.49)
Denver 3.56 (5.40) 4.15 (5.20)
Chicago 5.33 13.77) 4.31 (9.07)

(b) Future visitation

Bid $

Albuquerque 1.51 (1.91)[a] 5.08 (13.59)
Los Angeles 6.30 (19.36) 4.82 (7.02)
Denver 2 6 6 2) 4.15 (4.89)
Chicago 5.17 5.44) 5.56 (11.46)

Do not plan to visit in future   Plan to visit in future

[a] standard deviation in parentheses

73

Figure 19

Mean total regional bids of preservation value respondents, by city and past and future visitation

(a) Past visitation

Have not visited in past

Have visited in past

Bid $

11.69 (36.03)	Albuquerque
6.08a (14.98)	
10.28 (22.28)	Los Angeles
8.01 (11.86)	
6.53 (9.23)	Denver
6.97 (7.67)	
10.30 (24.95)	Chicago
9.97 (27.03)	

(b) Future visitation

Bid $

12.57 (38.82)	Los Angeles
8.84 (11.42)	
10.37 (29.76)	Albuquerque
2.67a (3.19)	
4.11 (9.02)	Denver
7.68 (8.45)	
11.46 (30.66)	Chicago
10.13 (21.59)	

Do not plan to visit in future   Plan to visit in future

'standard deviations in parentheses

74

Figure 20

Mean plume avoidance bids of preservation value respondents, by city and past and future visitation

□ Have not visited in past

▨ Have visited in past

(a) Past visitation

Bid

Albuquerque: 3.58 (11.04)[a], 5.34 (16.65)
Los Angeles: 3.05 (4.48), 2.30 (4.66)
Denver: 2.41 (4.90), 2.93 (3.78)
Chicago: 4.71 (15.20), 2.97 (5.44)

City

(b) Future visitation

Albuquerque: .73 (1.33)[a], 5.61 (15.59)
Los Angeles: 1.68 (2.51), 3.16 (4.89)
Denver: 1.92 (4.37), 3.32 (4.59)
Chicago: 6.87 (20.06), 2.72 (5.35)

City

□ Do not plan to visit in future

▨ Plan to visit in future

[a] standard deviations in parentheses

75
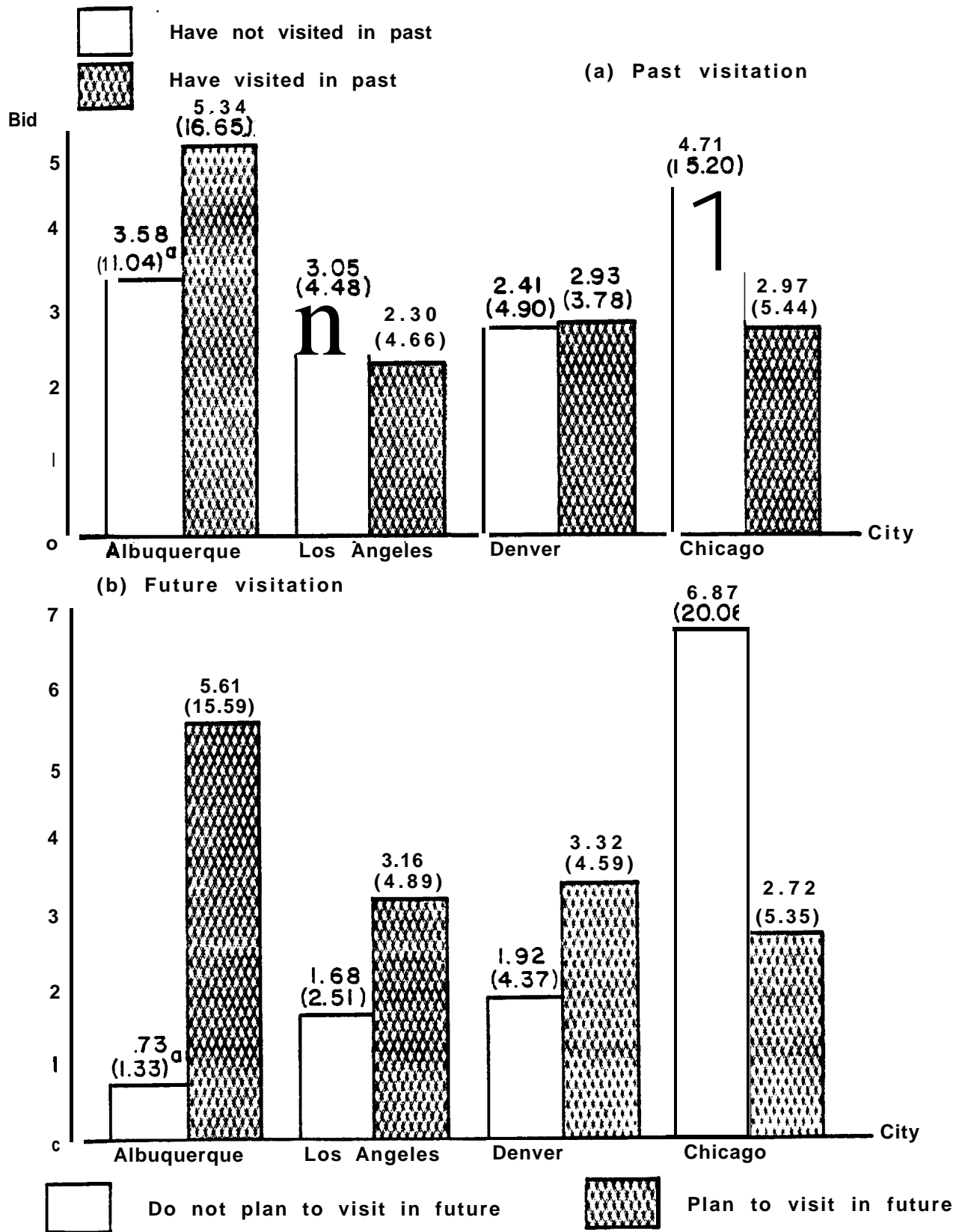
REFERENCES

1. See Chapter 6 for a discussion of the survey procedures used and the modifications adopted for the Chicago sample.

2. The name is taken from Rene Dubos who proposed that as the environment deteriorates people care less and less about further deterioration. In other words, people put a special value on pristine environmental conditions.

CHAPTER 8

AGGREGATE BENEFITS OF PRESERVING VISIBILITY

A. Introduction

This chapter will present aggregate benefit estimates for preserving visibility in the Grand Canyon and the southwest region as a whole. As discussed, the survey enabled revelation of the household's willingness to pay for preserving and/or improving visibility in specific parks of the Grand Canyon Region. Recall the bids stated by respondents in the preservation value section of the survey encompass both pure existence value and user's valuation of preserving visibility. Therefore, to estimate the visibility preservation benefits, it suffices to concentrate on and work with the preservation value section of the survey.

The benefits in question can be estimated by applying statistical techniques to the results of the survey conducted for this study. It can be hypothesized that the amount of the bids offered by interviewees to preserve and/or improve visibility in the areas where the survey focused is a function of certain relevant independent variables such as income, age, race and distance from a national park. Utilizing such a relationship we can estimate the benefits to residents of the southwest region as well as the entire nation resulting from the preservation of visibility in the Grand Canyon National Park and Parklands Region."

B. Estimating the Benefit Function for the Southwest

In estimating an individual mean dollar benefit function, certain characteristics of the sample population should be considered in that the cities of Los Angeles, Albuquerque, Denver and Chicago are not homogeneous. That is, in order to aggregate across all populations the demographic and economic profile of each city must be considered. Thus we hypothesize that a household bid is a function of family income, age of the family head, race, the household's distance from a national park and an error term.

To estimate the benefits to residents of the Southwestern U.S. (consisting of the following states: California, Colorado, Arizona, Utah, Nevada, and New Mexico) of preserving visibility in national parks three benefit functions have been estimated utilizing the Albuquerque, Denver, and Los Angeles data. Table 18 summarizes the estimated benefit functions. A brief analysis of the results follows.

Table 18

Benefit Functions Estimated from
Albuquerque, Denver, and Los Angeles Data

Bid for Preserving Visibility ($)	Constant	Income [$1000]	Age (years)	Race (white = 1) (nonwhite - 0)	Distance (miles)	R^2	Number of Observations
Grand Canyon	9.19 (4.23)[a]	.05 . (1.79)	-.14 (-4.01)	2.03 (1.69)	-.0037 (-1.2)	.06	352
Region (Grand Canyon, Mesa Verde and Zion)	18.11 (4.11)	.103 (1.79)	-.26 (-3.7)	3.69 (1.52)	-.0088 (-1.46)	.05	352
Plums Blight over the Grand Canyon	8.67 (4.54)	.0014 (.06)	-.12 (-4.02)	1.03 (.97)	-.0021 (-.81)	.05	352

at-statistics in parentheses

As Table 18 indicates, the relationship between income, age, race, distance and the amount of bid-offered is as expected. Higher levels of income should, normally, raise the amount of bid offered. Age contributes in a negative manner in all bid equations implying the young are seemingly more concerned with air quality problems in" the area. Since "whites," on average, fall in the "higher brackets" of income and education distribution in the United States compared to "nonwhites," it is reasonable to expect higher bids from whites than nonwhites. In addition, it is likely that "race" captures other social and cultural characteristics which are not easily observable. The relatively low t-statistic possibly reflects a substantial diversity within each of the "white" and "nonwhite" groups. The negative relationship between distance and the amount of bid offered indicates that the greater the distance from the national parks, the less their overall bid, However, the relationship between distance and the amount of bid offered is not strongly significant. Furthermore, as it will be seen shortly this result does not appear consistently in all of the analysis. Note also that the coefficient of determination (R^2) in all three benefit equations reported in Table 18 is extremely low. This indicates that there may be other important independent variables that affect the bidding behavior of the households, but which have not been accounted for in this study.

Nevertheless, it is possible to estimate the aggregate benefits accruing to the Southwest region of the United States from preserving visibility in the Grand Canyon National Park area. Let us first consider the benefit equation for the Grand Canyon (Row 1, Table 18). This equation indicates that if the average family income, average age of the head of households, ratio of white and nonwhites and the distance to the Grand Canyon from a particular state, say Arizona, is substituted in the equation, then the amount of bid an average household in Arizona would offer to preserve the visibility in the Grand Canyon would be estimated. Then if the benefit measure so estimated is multiplied by the number of households in the state of Arizona, the total amount of money that the entire population of Arizona would be willing to pay to preserve visibility in the Grand Canyon National Park is estimated. Following a similar

procedure, it is possible to est mate the aggregate benefits for the remaining five states in the Southwest reg on, and hence, the aggregate benefits to the Southwest region is estimated.

As Table 19 indicates, the aggregate benefits for the Southwestern region from preserving visibility in the Grand Canyon National Park, the encompassing region (Grand Canyon, Mesa Verde, and Zion) and for avoiding plume blight over the Grand Canyon is respectively $466 million, $889 million, and $373 million.

Table 19

Annual Aggregate Benefits for the
Southwest Region

Benefits for Preserving Visibility in the:	TOTAL ($ Millions)
Grand Canyon	466
The Region[a]- Grand Canyon, Mesa Verde and Zion National Parks	889
Avoidance of Plume Blight	373

[a]Benefits for the region include benefits for the Grand Canyon

c. Estimating Benefit Functions for the Nation

To estimate the aggregate national benefits from preserving visibility in the Grand Canyon National Park, surrounding region and for avoidance of plume blight, benefit functions in Table 20 are re-estimated, utilizing the interview data from Albuquerque, Denver, Los Angeles, and Chicago. Thus the principal difference will be the influence of the bids obtained from respondents in Chicago. Table 20 summarizes the re-estimated benefit functions which will be used to estimate the aggregate national benefits of preserving visibility.

Table 20
Benefi t   Functions Estimated from Albuquerque
Denver, Los Angeles, and Chicago Data

Bid for Preserving Visibility ($)	Constant	Income ($1000)	Age (years)	Race (white = 1) (nonwhite = 0)	Distance (miles)	R^2	Number of Observations
Grand Canyon	8. 36 (4. 76)	.047 (1.76)	-.15 (-4. 59)	1.14 (1.02)	.0004 (.39)	.05	450
Region (Grand Canyon, Mesa Verde and Zion)	15. 46 (4.41)	.11 (2.12)	-.29 (-4. 44)	2.29 (1.04)	.0004 (.19)	.05	450
Avoidance of Plume Blight over the Grand Canyon	8.6 (5.22)	-.003 (-1.78)	-.15 (-4.6)	1.14 (1.02)	-.00014 (-.16)	.05	450

[a] t-statistics in parentheses

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The benefit functions reported in Table 20 are for the most part similar to, and consistent with, the benefit equations obtained from the sub-sample of the Albuquerque, Denver, Los Angeles interviews reported in Table 18. Examination of Tables 18 and 20 reveal that the degree of significance of income is consistent in both sets of equations. Note that the significance of income in the "plume" benefit equation is lower than the other two equations in both Tables. Age remains strongly significant and consistent in the two sets of equations. The behavior of the variable "white/nonwhite" is very similar to that of the income. The direction of the relationship is consistent; so is the degree of significance among the benefit equations of each table as well as between the two tables. The only major difference is the relationship between distance and the amount of bid offered when the Chicago interviews are not included (Table 18) and included (Table 20). The direction of the relationship reverses itself from negative to positive when the Chicago data is added to the sample (except for the "plume" equation). Furthermore, significance level for the distance variable fails to be consistent. Without the Chicago data, distance is relatively more significant (except in the "plume's" benefit equation); after the Chicago data is added, the direction of relationship of this variable changes and it also fails to be significantly related to the amount of bid. Nevertheless, it is convincing to note that other than for the distance variable, when the sample size is increased by some 21%, (as Chicago data is added to the sample), the relationships remain consistent and stable.

The aggregate national benefit estimation procedure is identical with the procedure employed in the previous pages to estimate the benefits to the Southwest region. Aggregate benefits to all states (except Alaska and Hawaii, but with the addition of the District of Columbia) have been summed to arrive at the national aggregate benefits from preserving visibility. Table 21 summarizes the aggregate national benefits.

The benefits of preserving visibility for the Southwest and the Nation can be related to emissions by noting the following. Projected emissions with currently planned levels of SO_2 controls would not produce a perceivable decline in visibility in 1990 accoring to the calculations from Chapter 3. However, complete decontrol of projected regional power plant emissions of SO_2 in 1990 would decrease visibility by approximately the same amount as shown in the photographs which form the basis of these benefit estimates. Thus, one can interpret the aggregate bids to preserve regional visibility as the projected benefits of power plant SO_2 controls in 1990.

The annual figures presented in Tables 19 and 21 represent benefits to the Southwest and the nation for preservation of visibility in 1980. In order to obtain benefit estimates for 1990 power plant controls two modifications are required. First, the benefit figures are adjusted by the expected population growth over the next decade. Bureau of Census estimates " population growth of approximately one percent per year is expected. The present value of future benefits must be calculated. Assuming a thirty year life span for power generating plants and real rates of discount of 3, 6, and 9 percent, Table 22 summarizes the present discounted value of future benefits in constant 1980 dollars to the Southwest region and the entire nation from preserving visibility in the Grand Canyon National Park and the Parklands region.

Table 21

**Annual Aggregate National Benefits from Preserving
Visibility in the Grand Canyon National Park**

Benefits from	TOTAL ($ Millions)
The Grand Canyon	3,370
The Region - Grand Canyon, Mesa Verde, and Zion	5,760
Avoidance of Plume over the Grand Canyon	2,040

The **nine percent real discount rate case corresponds to a ten percent discount rate and a continued one percent growth in population. This case is therefore consistent with the Office of Management and Budget discount rate guidelines (10 percent) for assessment of future benefits. Thus, the nine percent case seems the most apropos** for comparison to the associated pollution control costs.

The comparison between benefits and costs can either be completed in present value or annual terms. Usuing the latter method requires annualization of the present value figures reported in Table **22. Focusing on the nine** percent discount rate case and using a capital **recovery factor based on a ten percent rate of interest the relevant annualized benefits for preservation of regional visibility are** $1.173 billion **and $7.6 billion for the southwest and nation, respectively.**

Clearly, preserving visibility in the Grand Canyon National Park region also entails certain costs. These include capital expenditures for SO$_2$ removal equipment, recurring annual expenditures and the cost of the regulatory system. The capital expenditures associated with SO$_2$ removal for all current and proposed power plants in the region (see Tables 4 and 5 for listing) are estimated to be approximately $5.3 billion or between 270 and 560 million dollars per year for real interest rates of three and ten percent and a thirty year life. In addition, the recurring annual expenditures are estimated to be 2 billion dollars per year. Finally, the regulatory system cost is approximately .534 billion dollars per year.** Therefore, total costs of currently planned SO$_2$ controls for the region are between 2.8 and 3.1 billion dollars annually (1980 dollars). Therefore, national benefits ($7.6 billion annually) exceed the total control costs and these approximate values indicate that the currently proposed level of control on SO$_2$ emissions are not without some economic justification.**

Table 22
Present value of future benefits
assuming thirty year life span for power
generating plants (in $ Million)

Benefits to" the Southwest from preserving visibility in	Discount Rate		
	3%	6%	9%
The Region - Grand Canyon, Mesa Verde and Zion National Parks	20,209	14,484	11,060

Benefits to the Nation from preserving visibility in	Discount Rate		
	3%	6%	9%
The Region - Grand Canyon, Mesa Verde and Zion National Parks	130,957	93,860	71,667

D.   Summary

There are three especially noteworthy observations which emerge from the above analysis in Chapters 7 and 8: 1) contrary to conventional thinking, survey respondents "placed a much higher value on higher levels of visual clarity than on comparable subsequent decreases; 2) neither past nor anticipated journeys to the Grand Canyon seemed to be important determinants of preservation value; and 3) distance from the Grand Canyon had little statistical significance in explaining the magnitude of household bids.

Because the Grand Canyon is the dominant feature in a region with many visitor attractions, one must be especially cautious in extending these findings to other recreational attractions. It seems likely that there are only a very few natural phenomena in the United States about which Americans have such strong feelings. Obvious candidates for this short list would be Old Faithful (in Yellowstone National Park), and Niagara Falls.

The magnitude of the annual benefits for the region when aggregated across households is impressive: $889 million in the Southwest and $5.76 billion in the nation. The present value of these benefits streams over thirty years, discounted at a 3 percent real rate, would be $20.2 billion and $131 billion, respectively.

In sum, the survey results revealed that Americans place great value on the preservation of air quality in the Parklands Region and that this valuation is not localized to residents in the Southwest. Further, it was found that pure existence value overwhelms a substantial user value for the national parks in the region.

Two qualifications are important in interpreting these results.

First, the accuracy of the survey techniques used in this study to estimate the benefits of preserving visibility in the Grand Canyon Region can be judged by comparison to other methodologies. Such comparisons suggest that all available techniques including survey methods, property value, wage and travel cost studies, are subject to errors of about plus or minus 50 percent (see Appendix B). It is inherently difficult to quantify environmental values in dollar terms, but available evidence indicates that the several techniques available all yield the same order of magnitude of benefits estimates when applied to the same problem.

Second, the principal benefits of preserving visibility in the Grand Canyon Region as estimated in this study, derive from the apparent desire of Americans to preserve a national treasure, whether or not they intend to visit or use the region themselves. Economists have termed this type of value "existence value." To our knowledge, this is the first study attempting to estimate existence values per se. Thus, the methodology used in this study should be viewed as experimental.

REFERENCES

1. sources for the state data are:

   Number of Households: Statistical Abstract of the United States, 1978, U.S. Department of Commerce.

   Incomes: Survey of Current Business, April, 1979, Vol. 59 #4, "County and Metropolitan Area Personal Income."

   Average Age and Race: Current Population Reports, Population Estimates and Projections.

2. **See Illustrative Projections of State Populations by Age, Race and Sex: 1975 to 2000, March 1979, U.S. Department of Commerce, Bureau of the Census.**

3. **The capital recovery factor is the rate which transforms an initial capital amount (present value) into a series of equivalent annual amounts, including both interest and capital.**

4. **See "Cost Analysis of Lime Based Flue Gas Desulferization Systems for New 500 Megawatt Utility Boilers," EPA document EPA-450/5-79-003 (January 1979), prepared by PEDCO Environmental, Inc.**

5. **Annual regulatory system costs are taken to be equal to the entire 1980 Environmental Protection Agency budget outlays for all air quality programs** plus an equal amount for private sector costs. This is an obvious over-estimate of the costs of power plant SO_2 control but more refined data **were not avilable. See the Department of Housing and Urban Development and Certain Independent Agencies Appropriations for Fiscal Year 1980, Part I-Justifications, hearings before a subcommittee on appropriations, U.S. Senate, Washington, D.C., 1980.**